FTD-TT- 64-323

TRANSLATION

THE NATURE OF GRAVITATION

By

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AIR FORCE SYSTEMS COMMAND

WRIGHT-PATTERSON AIR FORCE BASE

OHIO

FTD-TT- 64-323/1+2+4

UNEDITED ROUGH DRAFT TRANSLATION

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English Pages: 25

SOURCE: Byulleten' Vsesoyuznogo Astronomo-Geodezicheskogo Obshchestva, (Russian) Nr. 26, (33) 1960, pp. 3-14

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FTD-TT- -323/1+2+4 Date 8 May 19 64

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THE NATURE OF GRAVITATION

V. V. Radziyevskiy and I. I. Kagal'nikova

Introduction

The discovery of the law of universal gravitation did not immediately attract the attention of researchers to the question of the physical nature of gravitation. Not until the middle of the 18th century did M. V. Lomonosov [1] and several years later, Lesage [2, 3], make the first attempts to interpret the phenomenon of gravitation on the basis of the hypothesis of "attraction" of one body to another by means of "ultracosmic" corpuscles.

The hypothesis of Lomonosov and Lesage, thanks to its great simplicity and physical clarity quickly attracted the general attention of naturalists and during the next 150 years served as a theme for violent polemics. It gave rise to an enormous number of publications, among which the most interesting are the works of Laplace [4], Secchi [5], Leray [6], V. Thomson [7], Schramm [8], Tait [9], Isenkrahe [10], Preston [11, 12], Jarolimek [13], Waschy [14], Rysanek [15], Lorentz [16], D. Thomson (cited in [17]), Darwin [18], H. Poincare [19, 20], Majorana [21-25], and

Sulaiman [26, 27].

In the course of these polemics, numerous authors proposed various modifications to the theory of Lomonosov and Lesage. However, careful examination of each of these invariably led to conclusions which were incompatible with one or another concept of classical physics. For this reason, and also as a result of the successful elaboration of the general theory of relativity, interest in the Lomonosov-Lesage hypothesis declined sharply at the beginning of the 20th century and evidently it would have been doomed to complete oblivion, if in 1919-1922 the Italian scientist Majorana had not published the results of his highly interesting experiments. In a series of extremely carefully prepared experiments, Majorana discovered the phenomenon of gravitational absorption by massive screens placed between interacting bodies, a phenomenon which is easily interpreted within the framework of classical concepts of the mechanism of gravitation, but theretofore did not have an explanation from the point of view of the general theory of relativity.

The famous experimenter, Michelson [28], became interested in the experiments of Majorana. However, his intention to duplicate these experiments faded, evidently as a result of the critical article of Russel [29], in which it was shown that if the Majoran's gravitational absorption really did exist, then the intensity of ocean tides on two diametrically opposite points on the earth would differ almost 400 fold. On the basis of this calculation of Russel, Majorana's experimental results were taken to be groundless in spite of the fact that the experimental and technical aspect did not arouse any concrete objections.

In acquainting ourselves with the whole complex of pre-relativity ideas about the nature of gravitation, we were compelled to think of the possibility of a synthesis of the numerous classical hypothesis, such that each of the inherent, isolated, internal contradictions or disagreements with experimental data might be successfully explained. The exposition of this "synthesis." i.e., unified and modernized classical hypothesis of gravitation created primarily from the work of the authors cited above and supplimented only to a minimum degree by our own deliberations, is the main problem of this work. The other motive which has impelled us to write this article is that we have discovered the above mentioned objections of Russel against Majorana's experimental results to be untenable: from the point of view of the classical gravitation hypothesis no differential effect in the ocean tides need be observed. Therefore we must again emphasize that Majorana's experimental results deserve the closest attention and study. It seems to us that duplication of Majorana's experiments and organization of a series of other experiments which shed light on the existence of gravitation absorption are some of the most urgent problems of contemporary physics. Positive results of detailed experiments could introduce substantial corrections into even the general theory of relativity concerning the question of gravitation absorption within the framework of this theory, while still remaining a blank spot.

Evidently a strict interpretation of the Majorana phenomenon is possible only from the position of a quantum-relativistic theory of gravitation. However, insofar as this theory is still only being conceived it seems appropriate, as a first approximation, to

examine an interpretation of this problem on the basis of the "synthetic hypothesis" presented below, especially as the last includes the known attempts at a theory of quantum gravitation. We shall begin with a short exposition of the history of the question.

1. Discussion of the Lomonosov — Lesage hypothesis

According to the Lomonosov-Lesage hypothesis, outer space is filled with "ultracosmic" particles which move with tremendous speed and can almost freely penetrate matter. The latter only slightly impedes the momentum of the particles in proportion to the magnitude of the penetrating momentum, the density of the matter, and the path length of the particle within the body.

Thanks to spatial isotropy in the distribution and motion of ultracosmic particles, the cumulative momentum which is absorbed by an isolated body is equal to zero and the body experiences only a state of compression. In the presence of two bodies (A and B) the stream of particles from body B, impinging on body A, is attenuated by absorption within body B. Therefore, the surplus of the flux striking body A from the outer side drives the latter toward body B.

In connection with the Lomonosov-Lesage hypothesis, the question of the mechanism of momentum absorption immediately arises. Generally speaking the following variants are possible:

1. The overwhelming majority of particles pass through matter without loss of momentum, and an insignificant part are either completely absorbed by the matter or undergo elastic reflection (Schramm [8]). Evidently, in the first case constant "scooping" of ultracosmic particles by matter must take place,

leading to a secular decrease in the gravitation constant. In addition, as it is easy to show, in this case an inadmissable rapid increment of the body's mass must occur, if the speed of the ultracosmic particles is close to that of light. In the second case as Waschy [14] showed, the reflected particles must compensate for the anisotropy in the motion of the particles, which was created by the interacting bodies. In other words, the driving of the bodies in this case would be completely compensated for by the repulsion of the reflected particles and no gravitation would result.

2. All particles passing through matter experience something like friction, as a result of which they lose part of their momentum owing to a decrease in speed (Lesage [2, 3], Leray [6], Darwin [18], and others). Evidently in this case there would also be a gradual weakening of the gravitational interaction of the bodies (Isenkrahe [10]).

A way out from the described difficulty was made possible by the proposal of Thomasin (cited in 19, 17]), D. Thomson (cited in [17]), Lorentz [16], Brush [30], Klutz [31], Poincare [19, 20], and others, for a new modification of the Lomonosov-Lesage hypothesis, according to which the ultracosmic particles are replaced by extremely hard and penetrating electromagnetic wave radiation. If in this case we assume that matter is capable of absorbing only primary radiation and radiates secondary radiation, which still posesses great penetrating power, then the Waschy effect (repulsion of secondary radiation) may be eliminated.*

* However, in order that a secular decrease in the gravitation constant does not occur it is necessary to suppose that the quanta of secondary radiation, after being radiated, decompose to primary radiation and, as a consequence, at some distance, depending on the duration of their lives, the gravitational interaction between bodies approaches zero.

The next question which arises in connection with the Lomonosov-Lesage hypothesis concerns the fate of the energy which is absorbed by the body along with the momentum of the gravitational field. As Maxwell [32] and Poincare [19, 20] have shown, if we attribute to gravity a speed not less than the speed of light, then in order to ensure the gravitational force observed in nature it is necessary to accept that momentum is absorbed which is equal to an amount of energy that can transform all material into vapor in one second. However, these ideas lose their force when the ideas of Thomasin, G. Thomson, and Lorentz are considered, according to which the absorbed energy is not transformed into heat, but is reradiated as secondary radiation according to laws which are distinct from the laws of thermal radiation.

There was still one group of very ticklish questions connected with the astronomical consequences of the Lomonosov-Lesage hypothesis. As Laplace has shown [4], the propogation of gravitation with a finite speed must cause gravitational aberration, giving rise to so many significant disturbances in the motion of heavenly bodies that it would be possible to miss them only if the propogation velocity of gravitation exceeded the velocity of light by at least several million times.

Poincare [20] directed attention to the fact that the motion of even an isolated body must experience very significant braking as a result first of the Doppler effect (head-on gravitons become harder and consequently have more momentum than ones which are being overtaken) and second, the mass being absorbed sets the body in motion and a part of the body's own motion is communicated to the mass. So that this braking not be detected by observation, it

is necessary to assume that the speed of gravitational radiation exceeds the speed of light by 18 orders. This idea of Poincare is considered to be one of the strongest arguments against the Lomonosov-Lesage hypothesis.

Not too long ago a modification to the Lomonosov-Lesage hypothesis was suggested by the Indian academician Sulaiman.

According to this hypothesis, an isolated body A radiates gravitons in all possible directions isotropically, experiencing a resultant force equal to zero. The presence of a second body B slows the process of graviton radiation by body A more strongly, the smaller the distance between the bodies. Therefore the quantity of gravitons being radiated from the side of body A facing body B will be less than from the opposite side. This gives rise to a resultant force which is different from zero and tends to bring body A and body B together.

Further, Sulaiman postulated invariability of the graviton momentum with respect to a certain absolute frame of reference. Here the moving body must experience not braking, but rather acceleration coinciding with the direction of speed and being compensated by the braking influence of the medium.

Sulaiman's hypothesis is very interesting. Unfortunately, it does not examine the question of decreasing mass of the radiating bodies or the question of the fate of the radiated gravitons.

As can easily be shown by elementary calculation, so that the impulse being radiated by the body can secure the observed force of interaction between them, it is necessary that they lose their mass with an unacceptably great speed. It is completely clear that no combination of longitudinal and transverse masses can save the

thesis. There is a well-defined relationship between the relativistic expressions of the momentum and the energy [33], and it is impossible to imagine that a body radiating energy E (i.e., mass E/c^2) could with this momentum radiate more than E/c.

If we suppose that the radiation of the mass is compensated by the corresponding reverse process of graviton absorption, then we return to a more natural elementary variant of the Lomonoso-Lesage hypothesis. Graviton absorption and the screening effect which is inescapably linked with it guarantee a gravitational attraction force without the additional concept of anisotropic graviton radiation by one body in the presence of another.

2. Majorana's experiment, Russel's criticism.

Majorana did not insist in his investigations on a concrete physical interpretation of the law of gravitation. He simply started from the supposition that if there is a material screen between two interacting material points A and B, the force of their attraction is weakened by gravitational absorption of this screen [21, 22, 25]. As in the Lomonosov-Lesage hypothesis, Majorana took attenuation of the gravitational flux to be proportional to the value of the stream itself, the true density of the substance being penetrated by it, and the path length through the substance. The proportionality factor <u>h</u> in this relationship is known as the absorption coefficient. It is evident that with the above indicated supposition the relationship of the gravitational flux value to the path length must be expressed by an exponential law.

Let us imagine a material point which is interacting with an extended body. Since any element of this body's mass will be attracted to the material point with a force attenuated by screening

of that part of the body which is situated between its given element and the material point, on the whole the heavy mass of this body will diminish in comparison with its true or inert mass.

In his work [21], Majorana introduced a formula for the relationship between the heavy (apparent) mass M_α and the inert (true) mass M_υ of a spherical body of radius R and a constant true density δ_υ

$$M_a = \psi M_v = \frac{3}{4}\left[\frac{1}{u} - \frac{1}{2u^3} + e^{-2u}\left(\frac{1}{u^2} + \frac{1}{2u^3}\right)\right] M_v. \qquad (1)$$

where $u = \delta_\upsilon R$.

Expanding (1) into a series, it is easy to see that when $u \to 0$, $M_\alpha \to M_\upsilon$ and when $u \to \infty$, $M_\alpha \to \frac{\pi R^2}{h}$. From this

$$h \leqslant \frac{\pi R^2}{M_a}. \qquad (2)$$

Applying the result of (2) in the case of the sun, which is a body with the most reliably determined apparent weight, Majorana obtained

$$h \leqslant 7{,}65 \cdot 10^{-12}\, CGS. \qquad (3)$$

To experimentally determine the absorption coefficient <u>h</u> it is theoretically sufficient to weigh some "material point" without a screen and then determine the weight of this "material screen" after placing it in the center of a hollow sphere. If in the first case we obtain a value <u>m</u>, then in the second case we will register a decreased value as a result of gravitational absorption by the

walls of the hollow sphere

$$m_a = me^{-h\delta l} \simeq m(1 - h\delta l), \qquad (4)$$

where δ is the density of the material from which the screening sphere is made, and l is the thickness of its walls. Designating ε as the weight decrease $m - m_a$, we easily find that

$$h = \frac{\varepsilon}{m\delta l}. \qquad (5)$$

To determine the absorption coefficient value by formula (5), Majorana began, in 1919, a series of carefully arranged experiments, weighing a lead sphere (with a mass of 1274 g) before and after screening with a layer of mercury or lead (a decimeter thick).

After scrupulous consideration of all the corrections it turned out that, as a result of screening the weight of the sphere had decreased in the first series of experiments by $9.8 \cdot 10^{-7}$ g which yields, according to (5), $h = 6.7 \cdot 10^{-12}$. In the second series of experiments, $h = 2.8 \cdot 10^{-12}$ was obtained.

As already mentioned, in 1921 Russel came out with a critical article devoted to Majorana's work.

Assuming that the interaction force between two finite bodies is expressed by the formula

$$F = \frac{Gm_1\psi_1 m_2\psi_2}{r^2}, \qquad (6)$$

where, in accordance with expression (1)

$$\psi = \frac{3}{4}\left[\frac{1}{u} - \frac{1}{2u^3} + e^{-2u}\left(\frac{1}{u^2} + \frac{1}{2u^3}\right)\right],$$

and assuming at first that the decrease in weight as a result of self-screening occurs while leaving the inert masses unchanged, Russel obtained on the basis of (6) the third law of Kepler in the form

$$\frac{a_1^3}{a_2^3} = \frac{T_1^2}{T_2^2}\left[\frac{\psi_1}{\psi_2}\right]. \qquad (7)$$

The value of ψ, calculated by Russel with the absorption coefficient $\underline{h} = 6.73 \cdot 10^{-12}$ found by Majorana for several bodies of the solar system, is equal to:

Sun	0.33	Mars . . .	0.993
Jupiter . .	0.951	Moon . . .	0.997
Saturn . .	0.978	Eros . . .	1.000
Earth . . .	0.981		

From this it follows that the true density of the sun is not 1.41, but 4.23 g/cm².

Using the above tabulated values of ψ and Kepler's law, Russel showed convincingly that the corresponding imbalance between the heavy and inert masses of the planets would lead to unacceptably great deflections of their motions. In order that the deflection might remain unnoticed, it would be necessary for the absorption coefficient $\underline{h}$ to be 10^4 times the value found by Majorana. From this Russel came to the undoubtedly true conclusion that if as a result of self-screening the weight decrease found by Majorana did occur, then there would have to be a simultaneous decrease in their

inert masses.

Russel made this conclusion the basis of the second part of his article which was devoted mainly to investigation of the question of the influence of gravitational absorption on the intensity of lunar and solar tides. Following Majorana's ideas, Russel suggested that a decrease in attraction and necessarily also a decrease in the inert mass of each cubic centimeter of water in relation to the sun or moon would occur only if they were below the horizon. If this is admitted, then sharp anomalies in the tides must be observed, viz., the tides on the side of the earth where the attracting body is located must be less intense (2 times for lunar tides and 370 times for solar tides) than on the opposite side of the earth. In conclusion Russel contended that his calculations demonstrated the absence of any substantial gravitational absorption and that consequently Majorana's results are in need of some other interpretation. Russel himself, however, did not come to any conclusions in this regard.

While acknowledging the ideas presented in the first part of Russel's work to be unquestionably right, we must first of all state that the self-screening effect and the weight decrease associated with it cannot be seen as a phenomenon which is contradictory to the relativistic principle of equivalence: any change in a heavy mass must be accompanied by a corresponding change in the inert mass of the body. But is it possible to agree with the results of the second part of Russel's article, according to which gravitational absorption on the scale discovered by Majorana is contradicted by the observation data of lunar and solar tides? Let us remember that Russel came to this conclusion starting from

the freshly formed Majorana hypothesis of gravitational absorption only under the condition that the attracting bodies are on different sides of the screen. Meanwhile, application of the Lomonosov-Lesage hypothesis which painted a physical picture of gravitational absorption leads, as we will show in the following section, to conclusions which are completely compatible with Majorana's experimental results and with the concepts set forth in the first part of Russel's article, but at the same time, all of the conclusions about tide anomalies lack any kind of basis. Skipping ahead somewhat let us say in short that according to the Lomonosov-Lesage hypothesis, the weakening of attraction between two bodies must occur when a screen intersects the straight line joining them, regardless of whether there are gravitational bodies on various sides or on one side of this screen.

3. The "Synthetic" Hypothesis

Let us suppose that outer space is filled with an isotropic uniform gravitational field which we can liken to an electromagnetic field of extremely high frequency. Let us designate ρ as the material density of the field, keeping in mind with this concept the value of the inert mass contained in a unit volume of space. Evidently the density of that part of the field which is moving in a chosen direction within the solid angle $d\omega$ is $\rho\frac{d\omega}{4\pi}$. Under these conditions a mass of

$$d\mu = dS\rho\frac{d\omega}{4\pi}c, \tag{8}$$

carying a momentum

$$dp = dS\rho\frac{d\omega}{4\pi}c^2. \tag{9}$$

will pass through any area element dS in its normal direction within the solid angle $d\omega$ in unit time.

The mass flux (8) will fill an elementary cone, one cross section of which serves as the area element dS. At any distance from this area element, let us draw two planes parallel to it which cut off an elementary frustrum of height dl, and let us imagine that the frustrum is filled with material of density δ. It is evident that the portion of the flux (8) absorbed by this material will be

$$d\,(d\mu) = d\mu\, h\delta\, dl \tag{10}$$

or

$$d\,(d\mu) = h\rho c \frac{d\omega}{4\pi} dm, \tag{11}$$

where $dm = \delta\, dSdl$ is the mass of the elementary frustrum.

Let us imagine a "material point" of mass m in the form of a spherical body of density δ and of sufficiently small dimensions so that it is possible to neglect the progressive character of the absorption within it and to consider that the absorption proceeds in conformity with formula (11). Let us divide the section of this spherical body into a number of area elements and construct on each of them an elementary cone with an apex angle $d\omega$. Applying formula (11) to these cones, and integrating with respect to the whole mass of the material point, we obtain

$$\Delta\,(d\mu) = h\rho c \frac{d\omega}{4\pi} m. \tag{12}$$

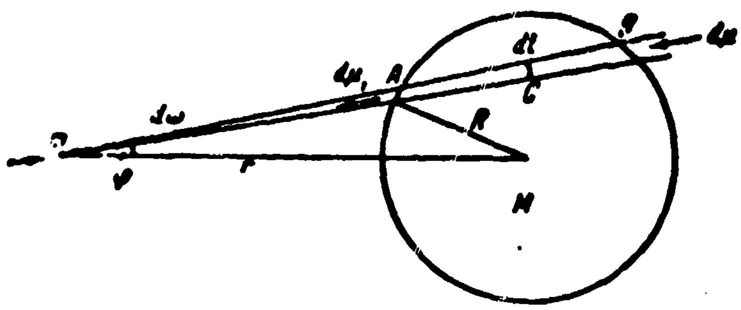

Fig. 1. Diagram for calculation of mass absorption of the flux of a material field.

Formula (12) determines the value of the absorbed portion of the field mass which has passed in unit time through a cone with an apex anble $d\omega$, which is circumscribed around a sufficiently small spherical body of mass m.

To obtain the total rate of increment in the mass of the point, it is necessary to take into consideration absorption of the field impinging on it from all possible directions, which is equivalent to integration (12) over the whole solid angle ω. This gives

$$\frac{dm}{dt} = h\rho cm. \qquad (12')$$

Returning to formula (10), imagine that the field flux inside the cone circumscribed around material point m, penetrates the material throughout the finite section of the path AB = l (Fig. 1).

Integrating (10) from B to A, we obtain an expression which determines the total absorption within the cone AB when δ = const

$$(d\mu)_l = d\mu e^{-h\delta l}. \qquad (13)$$

Let $d\mu$ be the mass of the field striking cone AB from side B, and $(d\mu)_1$ be the mass of the field exiting this cone and impinging on body m. The decrease in the mass of the flux because of absorption in AB is equivalent to the decrease in its density up to the value

$$\rho_1 = \rho e^{-h\delta l}. \quad (14)$$

Thus from the left flux of density ρ [its absorbed portion is expressed by formula (12)] strikes material point m, and from the right, a flux of density ρ_1. The portion which is absorbed will be

$$\Delta (d\mu)_1 = h\rho c e^{-h\delta l} \frac{d\omega}{4\pi} m. \quad (15)$$

Calculating (15) and (12) and multiplying the result by c, we obtain a vector sum of the momentum absorbed by point m in unit time equal to the value of force dF, from which point m is "attracted" to cone AB.

$$dF = h\rho c^2 \frac{d\omega}{4\pi} (1 - e^{-h\delta l}). \quad (16)$$

It would not be hard to show that with such a force, cone AB is "attracted" to point m.

Setting $l = dl$ in (16) we obtain the attraction force of point m to a cone of elementary length

$$d(dF) = h^2 \rho c^2 \frac{d\omega}{4\pi} m\delta dl. \quad (17)$$

As can be seen, force (17) at the assigned values of δ, $d\omega$, and dl depends neither on the distance between point m and the attracting

elementary frustrum, nor on the mass of the latter. This result corresponds completely to the data of Newton's theory of gravity and is explained by the fact that the mass of the frustrum being examined is directly proportional to the square of its distance from point m.

Differentiating (16) with respect to l, we obtain the value of the attraction force of point m to element C of cone AB, which also does not depend on the position of this element

$$d(dF) = h^2\rho c^2 \frac{d\omega}{4\pi} m e^{-h\delta l}\delta dl. \tag{18}$$

Comparison of (18) with (17) shows, however, that element C attracts point m with a weakened force and the degree of its weakening depends on the general thickness l of the screening material, regardless of whether point m and element C are on different or on the same side of the screen. The latter result is mathematical evidence of the groundlessness (within the frame of the Lomonosov-Lesage hypothesis) of the critical ideas in the second part of Russel's article.

Let us now determine the total attraction force of material point m to a spherical homogeneous body of mass M. Multiplying the right side of (16) by $\cos\varphi$ for this purpose and taking into account that $l = 2\sqrt{R^2 - r^2 \sin^2\varphi}$ and $d\omega = 2\pi \sin\varphi d\varphi$, we easily find that

$$F = \frac{h\rho c^2 m}{2} \int_0^{\arcsin\frac{R}{r}} \left(1 - e^{-2h\delta\sqrt{R^2 - r^2\sin^2\varphi}}\right)\cos\varphi \sin\varphi\, d\varphi = \frac{h^2\rho c^2}{4\pi}\frac{m\psi M}{r^2}, \tag{19}$$

where

$$\psi = \frac{3}{4}\left[\frac{1}{u} - \frac{1}{2u^3} + e^{-2u}\left(\frac{1}{u^2} + \frac{1}{2u^3}\right)\right]. \tag{20}$$

in which $u = h\delta R$.

As has already been noted above, $\psi \cong 1$ whence follows that the value

$$G = \frac{h^2 \rho c^2}{4\pi}. \tag{21}$$

plays the role of a gravitational constant. The value ψ which depends on progressive gravitation absorption within the body M must be considered to be the weight decrease coefficient of the latter.

In correspondence with the later experiments of Majorana, let us suppose that the coefficient of gravitation absorption is

$$h = 2{,}8 \cdot 10^{-12}. \tag{22}$$

Then on the basis of (21) we easily find that

$$\rho = 1{,}2 \cdot 10^{-4} \text{ г/см}^3. \tag{23}$$

Such a relatively high material density for outer space cannot meet objections, since the material of the gravitational field can almost freely penetrate any substance and is noticeable only in the form of the phenomenon of gravitational interaction of bodies. Now let us see how this business fares with the Doppler and aberration effects. It is quite evident that if the material behaves like a "black body," i.e., if it absorbs gravitational waves of any frequency equally well, then the Doppler effect will cause inadmissably intense braking of even an isolated body moving in a system, relative to which the total momentum of the gravitational field is equal to zero. Therefore, we are forced to admit

that matter absorbs gravitational waves only within a definite range of frequencies $\Delta\nu$ which is much greater than the Doppler frequency shift caused by motion, and at the same time substantially overlaps that region of the field spectrum adjacent to $\Delta\nu$, whose intensity may be considered to be more or less constant. It is easy to see that under these conditions, a moving body will not experience braking, just as a selectively absorbing atom moving in an isotropic field with a frequency spectrum having a surplus overlapping the whole absorption spectrum of the atom, does not exhibit the Poynting-Robertson effect.

Actually, in system Σ which accompanies the atom, the observer will detect from all sides absorption of photons of the same frequency corresponding to the properties of the atom. From the point of view of this observer, the resulting momentum borne by the photons which are absorbed by the atom will be equal on the average to zero. The mass of photons being absorbed in system Σ is not set in motion and therefore does not derive any momentum from the atom. On the other hand an observer in system S relative to which the field is isotropic, will detect that the moving atom is overtaken by harder photons and is met by softer photons. In other words it will seem to him that the atom absorbs a resulting momentum which differs from zero and is moving in the direction of the motion of the atom and compensates the loss of momentum, which is connected with the transmission of its absorbed mass of photons.

In this manner the observer in system S will also fail to observe either braking or acceleration of the atom's motion.

As concerns the effect of aberration, according to the apt remark of Robertson [34], which is completely applicable to a

gravitational field, consideration of this phenomenon is the worst method of observing the Doppler effect. Actually an isolated body such as the sun is a sink for the gravitational field being absorbed and a source for one not being absorbed. Since we are interested only in the form, we may say that in the presence of a body, something analogous to distortion of the gravitational field occurs: at each point of the field there arises a non-zero resulting momentum directed towards the center of the sink. Evidently such a momentum may collide with any other body only in a direction towards this center. The very fact of motion, as follows from the aforementioned considerations, cannot cause the appearance of a transversal force component.

Thus it is possible to see that the modernized Lomonosov-Lesage hypothesis presented here is not in conflict with a single one of the empirical facts which up to now have been discussed in connection with this hypothesis. At the same time, of course, it is impossible to guarantee that a more detailed analysis of the problem will not subsequently lead to discovery to such conflicts.

The Lomonosov-Lesage hypothesis not only makes it possible to easily interprete the Majorana phenomenon, but also in clarifying the essence of gravity it opens up perspectives for further investigations of the internal structure of matter and for a study of the possibility of controlling gravitational forces, and consequently the energy of the gravitational field. To illustrate the power of the energy, it suffices to recall that in the Majorana experiments the weight of the lead sphere, when introduced into the hollow sphere of mercury, decreased by 10^{-6} g, which is equivalent to the liberation of twenty million calories of gravitational

energy.

Most recently the authors have become aware of the experiments of the French engineer Allee who discovered the phenomenon of gravitational absorption by observations of the swinging of a pendulum during the total solar eclipse on June 30, 1954. In connection with this we feel compelled to mention that towards the end of the 19th century, the Russian engineer I. O. Yarkovskiy [35] was busying himself with systematic observations of the changes in the force of gravity, which resulted in the discovery of diurnal variations and a sharp change in the force of gravity during the total solar eclipse on August 7, 1887.

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